PATENT ABSTRACTS OF JAPAN

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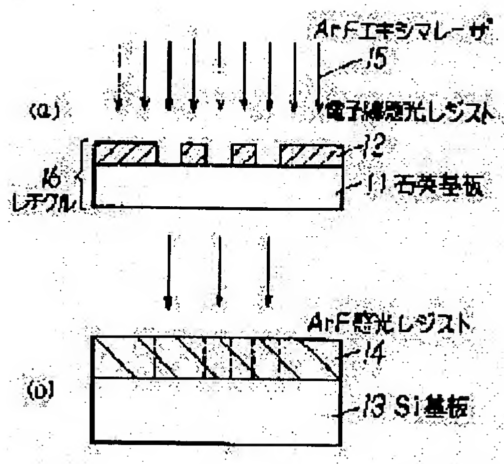
(54) RETICLE AND ITS PRODUCTION

(57)Abstract:

PURPOSE: To easily produce a reticle with high precision in the lithography using vacuum UV.

CONSTITUTION: An electron beam-sensitive resist 12 having almost 0% transmissivity to an ArF excimer laser (193nm) is applied on a quartz substrate 11, and a desired pattern is drawn on the resist 12 by an electron beam and developed to form a resist pattern. The resist pattern thus formed is used as a reticle in ArF excimer laser lithgraphy, and the reticle is easily produced with high precision. The reticle 16 is irradiated with an ArF excimer laser 15 to expose an ArF photosensitive resist 14 on an Si substrate 13, and a desired pattern is transferred with high contrast.



DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the manufacture approach of the structure of a reticle, and a reticle in the photolithography which makes vacuum-ultraviolet light the light source especially about the photolithography technique for micro processing of a semiconductor device.
[0002]
[Description of the Prior Art] Since a photolithography technique carries out contraction projection of the pattern by step-and-repeat one using a reticle and detailed pattern formation is [its throughput is high and] possible for it, it is a technique indispensable to the mass production of LSI. If numerical aperture of lambda and a lens is set to NA for the wavelength of light, as for the resolution R of a photolithography, the relational expression of R=k1 lambda/NA will be realized. However, k1 is a constant depending on a resist ingredient and a process. The photolithography using the light source of short wavelength is needed more as shown in this relational expression and detailed-ization progresses. Development of a VLSI is performed using the stepper which made the light source current, I line (365nm), and KrF excimer laser (248nm). In order to develop a still more detailed VLSI, the stepper which used the light source (vacuum-ultraviolet field) of short wavelength more becomes indispensable. For example, the stepper of ArF excimer laser (193nm) can be considered. On the other hand, the problem of increase of the reticle manufacturing cost accompanying the increment in the pattern amount of data and the process tolerance of a reticle arises as detailed-ization progresses.
[0003] The structure of the conventional reticle deposits the thin film of Cr on the protection-from-light section on a glass substrate. The manufacture approach of the conventional reticle is shown in (drawing 5). The Cr thin film 51 is deposited 80nm of thickness on the quartz substrate 11. The electron ray sensitization resist 12 is applied 500nm in thickness on said Cr thin film 51 (drawing 5 (a)). On the electron ray sensitization resist 12, an electron beam is used, it draws and the pattern of arbitration is developed (drawing 5 (b)). The electron ray sensitization resist 12 which carried out pattern formation is used as a mask using the etching reagent which dissolved 2nd cerium Amon of a nitric acid, and perchloric acid, and the Cr thin film 51 is etched (drawing 5 (c)). By the isotropic dry etching by O2 plasma, the electron ray sensitization resist 12 is removed and a reticle is formed (drawing 5 (d)).
[0004]
[Problem(s) to be Solved by the Invention] With the above configurations, since Cr thin film deposition, electron beam lithography, wet etching, resist removal, and the routing counter of the production process of a reticle increased, it had the trouble that cost became high. Moreover, in the process of the wet etching of Cr thin film, on the property of isotropic etching, since the pattern shift of a resist pattern dimension and Cr pattern finally formed arose, when detailed-ization progressed more, it had the trouble of it becoming impossible to disregard the process tolerance of a reticle.
[0005] This invention solves the above-mentioned technical problem, and aims at offering the manufacture approach of a highly precise reticle with few routing counters in the photolithography of a vacuum-ultraviolet field.

[0006]
[Means for Solving the Problem] The reticle characterized by equipping this invention with the structure of having a resist pattern, and changing on a glass substrate is offered. Especially, the above-mentioned reticle characterized by not penetrating said resist pattern to vacuum-ultraviolet light is offered. Furthermore, the reticle manufacture approach characterized by equipping this invention with the process which applies a resist, the process which exposes said resist, and the process which develops said resist, and changing on a glass substrate is offered. Especially, said resist offers the above-mentioned reticle manufacture approach characterized by not penetrating to vacuum-ultraviolet light. Moreover, the above-mentioned reticle manufacture approach characterized by the process which exposes said resist drawing with an electron beam is offered desirably. Furthermore, this invention offers the above-mentioned reticle manufacture approach characterized by adding the process which heat-treats said resist after the process which develops said resist.
[0007]
[Function] In this invention, on a glass substrate, the resist which does not show permeability to vacuum-ultraviolet light is applied and developed [expose and], a resist pattern is formed, and a reticle is manufactured. Since a resist pattern does not show permeability to vacuum-ultraviolet light, in the photolithography using vacuum-ultraviolet light, this resist pattern can grow into the protection-from-light section of a reticle as it is. That is, the pattern imprint of high contrast of the reticle formed with the resist pattern which does not penetrate vacuum-ultraviolet light is attained like the reticle formed with Cr thin film in the former. Therefore, to the processes of a conventional method being four processes of Cr thin film deposition, electron beam lithography, wet etching, and resist removal, the manufacture approach of the reticle of this invention is only one process of electron beam lithography, and can make a routing counter fewer than before. Moreover, in a conventional method, since the pattern shift of a resist pattern dimension and Cr pattern finally formed arose on the property of isotropic etching in the process of the wet etching of Cr thin film, there was a trouble that process tolerance was bad, but in this invention, since there is no etching process, a reticle can be manufactured more to high degree of accuracy. Moreover, in this invention, since a resist pattern is stiffened by heat-treating the resist pattern formed on the glass substrate, damage by the exposure of vacuum-ultraviolet light can be prevented.
[0008] Therefore, in the photolithography using vacuum-ultraviolet light, it acts effective in simple and highly precise reticle manufacture by using this invention.
[0009]
[Example] The reticle manufacture approach of one example of this invention is explained below, referring to a drawing. Here, the structure and the reticle manufacture approach of a reticle in the photolithography especially using ArF excimer laser of having used vacuum-ultraviolet light are explained.
[0010] (Drawing 1) shows the structure of a reticle and the explanatory view of the ArF excimer laser exposure approach in the example of this invention. The structure of a reticle carries out pattern formation of the electron ray sensitization resist 12 on the quartz substrate 11. The ArF excimer laser exposure approach irradiates the ArF excimer laser 15 on the reticle 16 of the structure mentioned above, and performs a pattern imprint on the ArF sensitization resist 14 applied on the Si substrate 13. The ultraviolet transparency property of the electron ray sensitization resist 12 and the ArF sensitization resist 14 described above to (drawing 2) is shown. As shown in drawing, in the electron ray sensitization resist 12, the ArF sensitization resist 14 used the thing of about 80% of transmission using that from which transmission becomes about 0% to ArF (193nm). Thus, in ArF excimer laser lithography, the imprint of high contrast of the electron ray sensitization resist 12 is attained by choosing the ingredient which is not penetrated to ArF (193nm).
[0011] (Drawing 3) shows the process sectional view of the reticle manufacture in the 1st example of this invention. As shown in (drawing 2), the electron ray sensitization resist 12 from which transmission becomes about 0% to ArF (193nm) was applied 500nm of thickness on the quartz substrate 11, and the electron ray sensitization resist 12 was heat-treated for 60 seconds at 90 degrees C (drawing 3 (a)). The electron ray was irradiated on the electron ray sensitization resist 12 applied on the quartz

substrate 11, the desired pattern was drawn, the electron ray sensitization resist 12 was developed, the resist pattern was formed, and the reticle was manufactured (drawing 3 (b)).

[0012] As mentioned above, according to this example, since the resist pattern formed on the quartz substrate does not show permeability to ArF excimer laser, in the photolithography using ArF excimer laser, this resist pattern can grow into the protection-from-light section of a reticle as it is. That is, the pattern imprint of high contrast of the reticle formed with the resist pattern which does not penetrate the ArF excimer laser in this example was attained like the reticle formed with Cr thin film in the former. Therefore, to the processes of a conventional method being four processes of Cr thin film deposition on a quartz substrate, the pattern formation by electron beam lithography, the wet etching of Cr thin film, and resist removal, the manufacture approach of the reticle of this example is only one process of the pattern formation by electron beam lithography, and was able to make the routing counter fewer than before. Moreover, although there was a trouble that process tolerance was bad, in a conventional method since the pattern shift of a resist pattern dimension and Cr pattern finally formed arose on the property of isotropic etching in the process of the wet etching of Cr thin film, in this example, since there is no etching process, there is no problem of a pattern shift, and the reticle was able to be manufactured more to high degree of accuracy.

[0013] In addition, in this example, although the structure and the manufacture approach of a reticle in the photolithography which made the light source vacuum-ultraviolet light, especially ArF excimer laser (193nm) were shown, when light of other wavelength is made into the light source, permeability should just become even about 0% to the light which the resist which carried out pattern formation on the quartz substrate similarly uses as the light source. Moreover, although electron beam lithography was used for the pattern formation of the resist on a quartz substrate in this example, a photolithography may be used as long as the resist fulfills the conditions that permeability becomes about 0% to the light used as the light source of a pattern imprint of this reticle. Moreover, to the light used as the light source of a pattern imprint of this reticle, although the quartz was used for the substrate in this example, as long as permeability is fully high, other glass ingredients may be used.

[0014] (Drawing 4) shows the process sectional view of the reticle manufacture in the 2nd example of this invention. As shown in (drawing 2), the electron ray sensitization resist 12 from which transmission becomes about 0% to ArF (193nm) was applied 500nm of thickness on the quartz substrate 11, and the electron ray sensitization resist 12 was heat-treated for 60 seconds at 90 degrees C (drawing 4 (a)). The electron ray was irradiated on the electron ray sensitization resist 12 applied on the quartz substrate 11, the desired pattern was drawn, the electron ray sensitization resist 12 was developed, and the resist pattern was formed (drawing 4 (b)). Far ultraviolet rays 41 were irradiated on the electron ray sensitization resist 12 which carried out pattern formation, the electron ray sensitization resist 12 was heat-treated for 120 seconds at 200 degrees C, the electron ray sensitization resist 12 was stiffened, and the reticle was manufactured (drawing 4 (c)).

[0015] As mentioned above, according to this example, since the resist pattern formed on the quartz substrate does not show permeability to ArF excimer laser, in the photolithography using ArF excimer laser, this resist pattern can grow into the protection-from-light section of a reticle as it is. That is, the pattern imprint of high contrast of the reticle formed with the resist pattern which does not penetrate the ArF excimer laser in this example was attained like the reticle formed with Cr thin film in the former. Therefore, to the processes of a conventional method being four processes of Cr thin film deposition on a quartz substrate, the pattern formation by electron beam lithography, the wet etching of Cr thin film, and resist removal, the manufacture approach of the reticle of this example is only one process of the pattern formation by electron beam lithography, and was able to make the routing counter fewer than before. Moreover, although there was a trouble that process tolerance was bad, in a conventional method since the pattern shift of a resist pattern dimension and Cr pattern finally formed arose on the property of isotropic etching in the process of the wet etching of Cr thin film, in this example, since there is no etching process, there is no problem of a pattern shift, and the reticle was able to be manufactured more to high degree of accuracy. Moreover, especially, by this example, since far ultraviolet rays were irradiated on the resist and the resist was hardened after carrying out resist pattern formation, there is no

damage by ArF excimer laser exposure, and the dependability of a reticle was able to be improved. [0016] In addition, in this example, although the structure and the manufacture approach of a reticle in the photolithography which made the light source vacuum-ultraviolet light, especially ArF excimer laser (193nm) were shown, when light of other wavelength is made into the light source, permeability should just become even about 0% to the light which the resist which carried out pattern formation on the quartz substrate similarly uses as the light source. Moreover, although electron beam lithography was used for the pattern formation of the resist on a quartz substrate in this example, a photolithography may be used as long as the resist fulfills the conditions that permeability becomes about 0% to the light used as the light source of a pattern imprint of this reticle. Moreover, to the light used as the light source of a pattern imprint of this reticle, although the quartz was used for the substrate in this example, as long as permeability is fully high, other glass ingredients may be used. Moreover, although far ultraviolet rays were irradiated in this example at hardening of a resist pattern, a substrate may be heated directly and a resist pattern may be stiffened.

[0017]

[Effect of the Invention] as explained above, in order to use the resist which exposed and developed [apply and] the resist which does not show permeability to vacuum-ultraviolet light on a glass substrate, and formed and carried out pattern formation of the resist pattern as it is as a reticle in the photolithography which used vacuum-ultraviolet light for the light source according to the reticle and the reticle manufacture approach of this invention, a routing counter is decreased from the production process of the reticle using Cr thin film of a conventional method -- things can be carried out. It contributes to reduction of a reticle manufacturing cost greatly by reduction of this routing counter. Moreover, although there was a trouble that process tolerance was bad, in a conventional method since the pattern shift of a resist pattern dimension and Cr pattern finally formed arose on the property of isotropic etching in the process of the wet etching of Cr thin film, in this invention, only at the process of the pattern formation of a resist, since there is no etching process, there is no problem of a pattern shift, and a reticle can be manufactured more to high degree of accuracy. Moreover, especially the process that heat-treats the resist which carried out pattern formation in this invention can stiffen a resist, can prevent damage by the exposure of vacuum-ultraviolet light, and can be contributed to manufacture of a reliable reticle. Therefore, since it acts effective in highly precise reticle manufacture by low cost in the photolithography using vacuum-ultraviolet light by using this invention, it can contribute to manufacture of super-large scale integration greatly.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The structure of a reticle and the explanatory view of the ArF excimer laser exposure approach in the 1st example of this invention
[Drawing 2] The ultraviolet transparency property Fig. of an ArF sensitization resist and an electron ray sensitization resist in drawing 1
[Drawing 3] The process sectional view of the reticle manufacture in the 1st example of this invention
[Drawing 4] The process sectional view of the reticle manufacture in the 2nd example of this invention
[Drawing 5] The process sectional view of the conventional reticle manufacture
[Description of Notations]
11 Quartz Substrate
12 Electron Ray Sensitization Resist
13 Silicon Substrate
14 ArF Sensitization Resist
15 ArF Excimer Laser
16 Reticle
41 Far Ultraviolet Rays
51 Cr Thin Film

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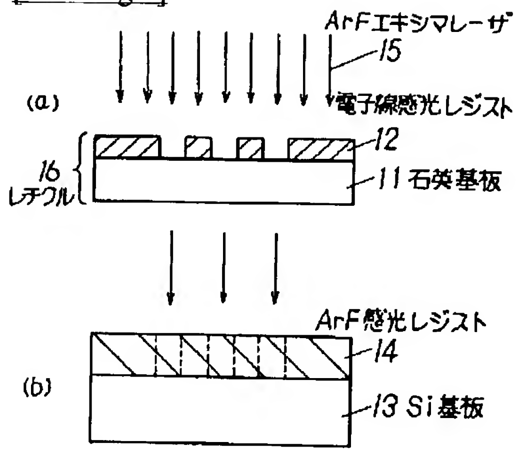
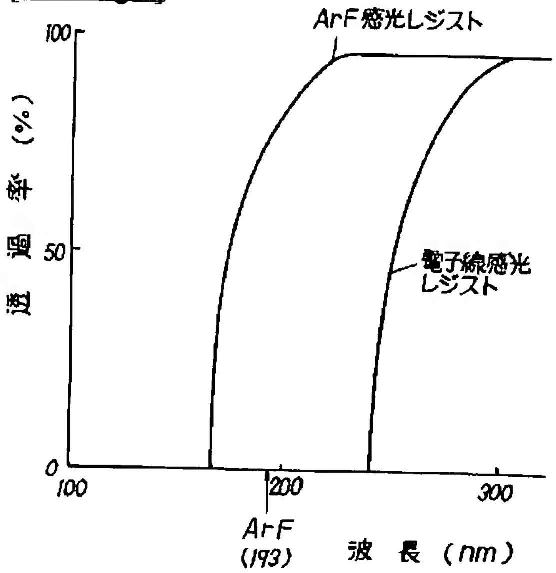
* NOTICES *

DRAWINGS

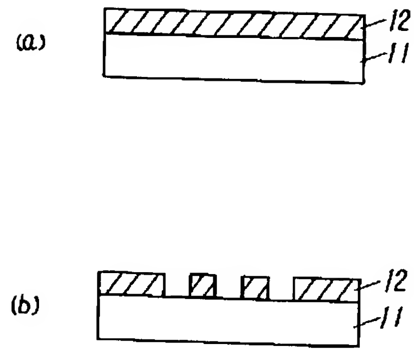
[Drawing 1]



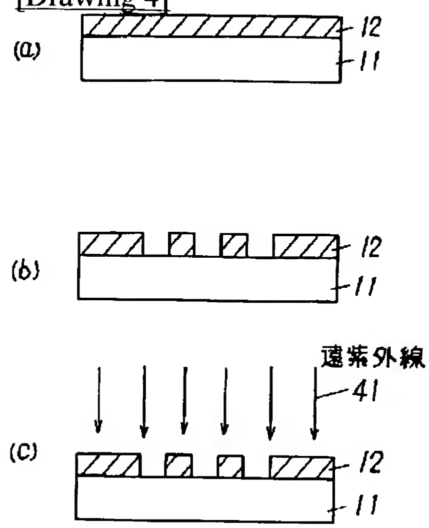
[Drawing 2]



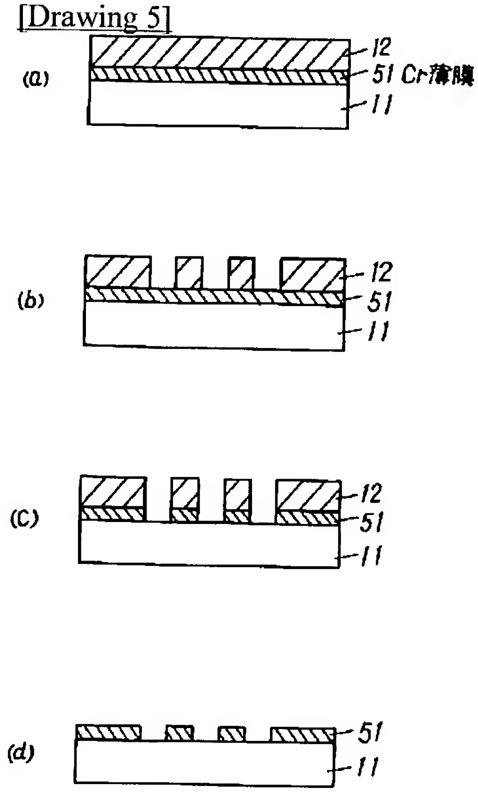
[Drawing 3]



[Drawing 4]



[Drawing 5]



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